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Story of Ancient Life

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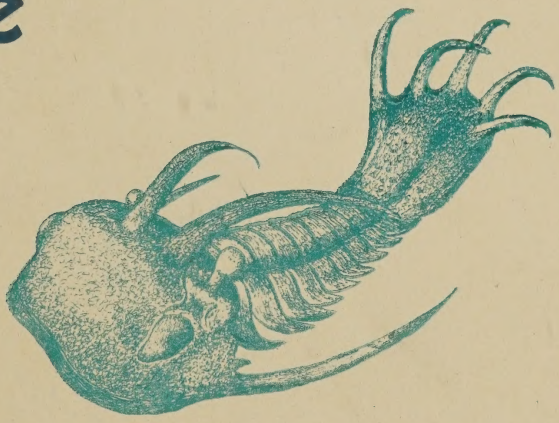


By
MADELEINE A. FRITZ

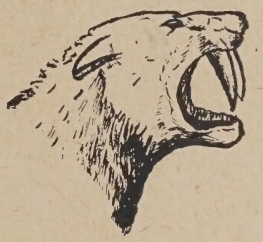
Royal Ontario Museum of Palaeontology
PAMPHLET SERIES, No. 1

Story of Ancient Life

DIVISIONS OF GEOLOGICAL TIME
SHOWING DEVELOPMENT OF PLANT AND ANIMAL LIFE

ERA	PERIOD	ROCKS	DOMINANT LIFE		
CENOZOIC 50,000,000 Years	TERTIARY		ACE of MAMMALS		PLANTS
MESOZOIC 150,000,000 Years	CRETACEOUS		ACE of AMMONITES	ACE of SEED	MODERN
	JURASSIC		ACE of REPTILES and	ACE of SEED	PLANTS
	TRIASSIC				
PALAEOZOIC 350,000,000 Years	PERMIAN		ACE of AMPHIBIANS		ANCIENT
	CARBONIFEROUS		ACE of	SPORE AGE of BEARING	PLANTS
	DEVONIAN		ACE of FISHES and CORALS		
	SILURIAN		ACE of INVERTEBRATES		SEA-WEEDS
	ORDOVICIAN				
	CAMBRIAN				
PROTEROZOIC 900,000,000 Years	PRECAMBRIAN		RISE of INVERTEBRATES	ACE of	
ARCHAEOZOIC 500,000,000 Years					

Story of
ANCIENT LIFE



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Contents

How the history of the past is read	1
When the earth began	2
How geological time is measured	2
Beginnings of life	3
Nature's calendar	4
How fossils got in the rocks	5
Early fossil types	6
Higher animals and plants appear	8
The age of reptiles	10
"The mammals inherit the earth"	14
Man takes over	17
Epilogue	21

Illustrations

Divisions of geological time showing development of plant and animal life *Frontispiece*
Trilobite, brachiopods, corals, chambered nautiloid, eurypterid, graptolites, sea-lily 7
Armoured fish 8
Primitive shark 9
Amphibian and dragon-fly with early horsetail plants 10
Ammonites and belemnites 11
Cretaceous scene showing a carnivorous and duckbill dinosaur, flying reptile, and primitive seed-bearing plants 12
Archaeopteryx, the first bird 14
An early Cenozoic horse 16
Cro-Magnon man 19

Story of Ancient Life

How the history of the past is read. To many of us ancient history begins when records of some kind were made that could be read or otherwise interpreted by people of the present day. In the popular sense this idea is correct. It is true that we can read the history of ancient Greece and Rome. Furthermore, it is possible to interpret the strange characters left to succeeding generations by still older human civilizations that are being unearthed from time to time. Even the oldest of these civilizations, however, date back only a few thousand years, and while they may seem ancient according to our standard of reckoning, they appear but as yesterday on the calendar of Mother Nature.

Long before man appeared on the earth race after race of primitive creatures inhabited the seas and lands in an orderly succession. These races handed down no inscribed records to posterity but the remains, chiefly of their hard parts, which are entombed in certain rocks as "fossils," serve as documents to reveal much of the history of the age in which each lived. Such ancient history as this is dealt with in the branch of science known as *Palaeontology*, which in simple language means "the story of ancient life."

In this booklet an attempt will be made to trace through the ages, by means of the fossil record, the vast procession of life which started countless millenniums ago with the primitive organisms, and which is still

marching on to-day, composed at present of the living things with which we are now familiar.

When the earth began. It will very likely seem strange to some who read these pages to learn that at one time in the history of the world it was, in all probability, a lifeless planet. According to a current hypothesis the earth, about three billion years ago, was a tremendously hot gaseous mass, which eventually started revolving about the sun from which it had been expelled. So high were the temperatures that no form of life, however primitive, could possibly live therein. As time went on, cooling took place and a crust gradually formed from the combination of elements that existed in the primordial atmosphere. When this crust of the globe cooled sufficiently so that water falling upon it did not return as vapour to the outer regions but, instead, remained in crustal depressions, then the primary oceans developed. This event dates back about two billion years.

How geological time is measured. Face to face with these staggering figures the question arises—how are these estimates arrived at? What evidence is there to justify these statements? The phrase "time immemorial" becomes real indeed when viewed in the light of these enormously long periods. "How old is the earth?" is a question upon which philosophers have speculated all down the ages. As scientific thought developed various methods of computing the age of the earth have been considered. They have been based, for the most part, upon observations of the results of some natural process that has operated steadily upon or within the earth. A method that finds much favour nowadays has to do with radio-active substances that are dispersed through-

out the rocks. It is this method which gives the long periods of time that scientists now consider necessary to bring about the geological features recognized to-day. These radio-active substances are commonly found in granites and pitchblende. It will be remembered that Madame Curie first discovered radium, one of these elements, in pitchblende from Bohemia.

The common property of radio-active elements is that they are continually losing part of their substance by giving off invisible radiations. During their subsequent disintegration the element changes to something different. Thus uranium breaks down through a series of changes into thorium, lead, and helium. The rate of disintegration can be mathematically computed. By measuring carefully the relative proportions of these elements in a given rock and knowing the rate of disintegration, it is possible to determine the time it took the original element to break down. This time would represent the approximate age of the rock in which the element was found. Accordingly, rocks of about two billion years have been determined.

Beginnings of life. With the crust formed and the oceans flowing, historical geology begins. In these primary waters we believe that life, in its most elemental state, first appeared. It was in all probability of the one-celled type, not yet differentiated into animal or plant, but merely living matter. Later came the separation into one-celled plants and animals. From these lowly organisms developed, it is believed, the many and varied forms of life that are known to have existed through the ages. Since these very early creatures were soft and jelly-like, and of microscopic dimensions, they were incapable of becoming fossilized, and so their

remains are not preserved. During the eons that followed, primitive multicellular organisms must have developed in the seas, but they, like their predecessors, were for the most part soft-bodied. When they died they fell to the sea-bottom and were soon destroyed. In due time, however, shellfish appeared. The shells could better resist the many hazards to which they were subjected, and so they stood a fair chance of being preserved, particularly if buried quickly in the muds. However, in spite of the fact that shellfish must have been present in the later primary oceans, no undisputed fossils are found in sediments older than a half billion years. Prior to that date volcanoes were probably more active in the world than at any subsequent time. The molten lavas, welling up and breaking through rocks that contained the oldest fossils, were responsible in no small measure for destroying the earliest records.

Nature's calendar. It is an established fact that the deposition of sediments in prehistoric seas has given rise to most of the stratified rocks of to-day. Each group of rock strata represents a time which may be measured from hundreds of thousands to millions of years. The subdivisions of geological time or, more popularly speaking, of nature's calendar, are based upon the succession of these ancient sediments, which are separated by rhythmical interruptions or breaks in sedimentation.

In the time-chart represented in the frontispiece an imaginary vertical cut through the rocks (for the most part sedimentary) of the earth's crust from the oldest to the youngest, is shown. It is highly improbable that at any one place such a series of rocks would be found. By piecing together, however, information obtained at various places in the world, it is possible to build up

such a tabular arrangement. Frequent reference to this time chart should be a great help to the reader in following the story as it proceeds.

It will be noted that the largest subdivisions recognized are called "eras," of which there are five in number. The ending *-zoic*, common to all five, comes from the Greek word meaning "life." Thus the oldest era, *Archaeozoic*, means "beginning of life"; followed by *Proterozoic*, "very little life"; then *Palaeozoic*, "ancient life"; *Mesozoic*, "middle life"; and *Cenozoic*, "recent life." These stages suggest the great changes in the development of life and they constitute a very important part of the earth history.

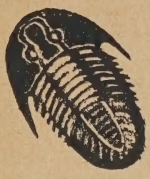
The eras are divided into periods. Their names are derived mainly from European sources, owing to the fact that much of the early geological work was done on that continent. In many instances the period names are geographic in origin, but a few are descriptive terms, applicable to the rocks, such as Carboniferous, "coal bearing," and Cretaceous, meaning "chalk."

How fossils got in the rocks. It has already been pointed out that life, though probably present in the Archaeozoic and Proterozoic, left behind no direct evidence of its existence. Another glance at the chart will show that these eras represent by far the greater part of geological time. With the beginning of the Palaeozoic era, however, life in the seas was well established. Fossil-bearing rocks of the early Cambrian period conclusively prove this fact.

It may not be clear to some just how fossilized shells actually got in the rocks. In order to explain this phenomenon let us suppose that the continent of North America were depressed about 600 feet. It would then

be found that the oceanic waters of the eastern part of the continent would encroach slowly upon the present land. Hudson Bay would be more extensive, the Gulf of St. Lawrence would be much expanded, the Atlantic and the Gulf of Mexico would flood larger regions. Over the land areas thus submerged by marine waters, sediments in the form of muds, sands, and limey oozes would accumulate. In these sediments would be buried many of the bottom-dwelling shellfish such as corals, molluscs, and crustaceans, along with possibly a few teeth of sharks and bones of whales. If the continent were then uplifted and the oceans drained off, the sedimentary deposits with their fossils would bear witness to this imaginary submergence. Just such submergences have occurred again and again in the past, leaving behind, in an orderly succession, their sediments (now rocks) along with their entombed fossils. Fossils thus serve to tell the time at which the rocks, in which they are found, were formed. From successive records of this kind we can read as from a book the history, in chronological order, of prehistoric life. Unfortunately, for various reasons many of the chapters and pages are missing, but from what remains preserved it is possible to determine, with almost unbelievable accuracy, the range through time of the main groups of animals and plants.

Early fossil types. During the first half of the Palaeozoic era, i.e. up to and including the Devonian, most of the life was confined to the sea. Invertebrates (animals without a backbone) and seaweeds constituted the ruling types. Outstanding among the animals were the trilobites, eurypterids, brachiopods, graptolites, crinoids (sea-lilies) corals, and chambered nautiloids.

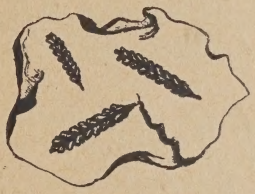


TRILOBITE

EURYPTERID

BRACHIOPODS

CORALS

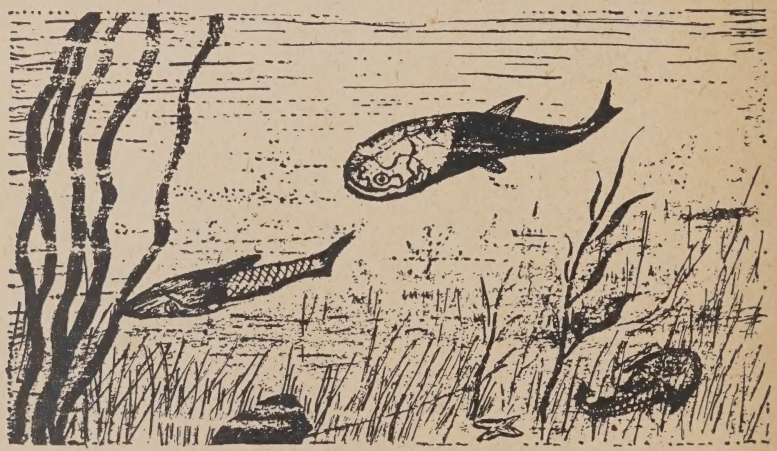


GRAPTOLITES

CHAMBERED NAUTILOID

SEA-LILY

Of these forms the trilobites, remotely related to the lobsters and crabs of to-day, and the eurypterids, or sea-scorpions, are now extinct. The graptolites, primitive floating creatures, drifted around freely in the oceans, became world-wide in their distribution, and finally disappeared in these ancient seas. Of the other groups mentioned, the brachiopods, often called lamp-shells, were more numerous than at any subsequent time in earth history, while the corals abounded for the first time in the Silurian and Devonian. In the warm clear waters corals formed reefs in which many different kinds were present, both of the solitary and colonial variety. The chambered nautiloids, devil-fish of their day, and now practically gone, were likely the strongest and most predaceous creatures yet known.



Armoured Fish

Higher animals and plants appear. During the Age of Corals strange fish-like, armour-plated creatures, as well as many varieties of true fish, appeared. Primitive,

succulent land plants, of the spore-bearing variety, developed.

In the succeeding periods of the Palaeozoic still greater advances were made both in the plant and animal

Primitive Shark

world. Amphibians, represented to-day by frogs, toads, and salamanders, crawled about in the vast swampy areas. While some of these animals were no larger than modern varieties, others attained a length of six feet or more.

Among the primitive land plants, huge horse-tails, giant club-mosses, and towering seed ferns flourished in vast swamps throughout the world.

Great dragon-fly-like insects, with a wing spread of nearly three feet, flew in and out among the trees. Cockroaches six inches long scurried over the ground, millepedes crawled sluggishly over the sodden logs.

When the trees died, they fell into the swamps and some were quickly covered over by the muddy waters, thus preventing their decay. As many millions of years passed, layers and layers of buried forest were changed

into coal through pressure, heat, and other agencies. Much of the world's present coal supply was thus formed.

By the end of the Palaeozoic era, therefore, it will be noted that life was well established on the land. In the

AMPHIBIAN AND DRAGON-FLY WITH EARLY HORSE-TAIL PLANTS

three hundred and fifty million years since fossils first appeared in the rock strata, by far the most fundamental changes had taken place in the organic world. Yet life was still primitive as compared with what followed.

The Age of Reptiles. With the beginning of the Mesozoic era many of the old races of animals and plants had passed the peak of their development, and had declined or disappeared entirely from the earth. New races, however, higher in organization than their predecessors, did not fail to appear. And so it is not surprising to find the amphibians giving place to the reptiles, and spore-bearing plants being replaced gradually by the seed-bearers, among which conifers, cycads, and gingkos are outstanding. Among the invertebrates the ammonites

and belemnites, related respectively to the present-day nautilus and squid, appeared, flourished, and died.

In spite of many new and interesting lineages, clearly traced by means of fossils, nevertheless the Reptiles,

Ammonites and Belemnites

above all others, were the most spectacular creatures in the Mesozoic. They swam in the seas, they dominated the lands, and they flew through the air. Outstanding among the land reptiles were the dinosaurs (terrible lizards). These cold-blooded, egg-laying, stiff-jointed, hairless creatures were at this time the lords of creation. They ranged in size from small forms not larger than a fowl to huge forms a hundred feet long. Skeletons of dinosaurs have been found in Mesozoic rocks of all the continents, with the possible exception of Australia, but chiefly in Europe and North America. In Canada most of the splendid specimens in the world-famous collection of the Royal Ontario Museum came from the Cretaceous rocks that now form the banks of the Red Deer River in southern Alberta. These rocks were formed in a shallow sea that covered Alberta in the above-mentioned period, from one hundred to fifty million years ago.

Along the swampy borders of this ancient sea the dinosaurs wallowed in the muds or battled for supremacy in the more open spaces of the tangled jungles. When they died some individuals from these great primeval hordes were buried in the muddy sediments. Later

Cretaceous Scene Showing a Carnivorous and Duckbill Dinosaur, Flying Reptile, and Primitive Seed-Bearing Plants

the sea retreated and the sediments, now rocks, were left behind with their entombed treasures.

In a broad way the dinosaurs may be classified into two groups—plant-eaters and flesh-eaters. The character of the teeth, among other things, provides evidence for such a subdivision. In the collection at the Royal Ontario Museum varied examples of each of these types may be seen.

Among the many kinds of plant-eaters the "duckbills," named from the apparent resemblance to a duck's mouth, stand out preeminently. On an average these specimens are about 17 feet tall and from 25 to 30 feet long. They are bipedal in habit, with a long tail. Their front limbs are relatively short. There is evidence to support the view that they were web-footed, thus indicating that they spent considerable time swimming about in the water, in all probability to escape their enemies.

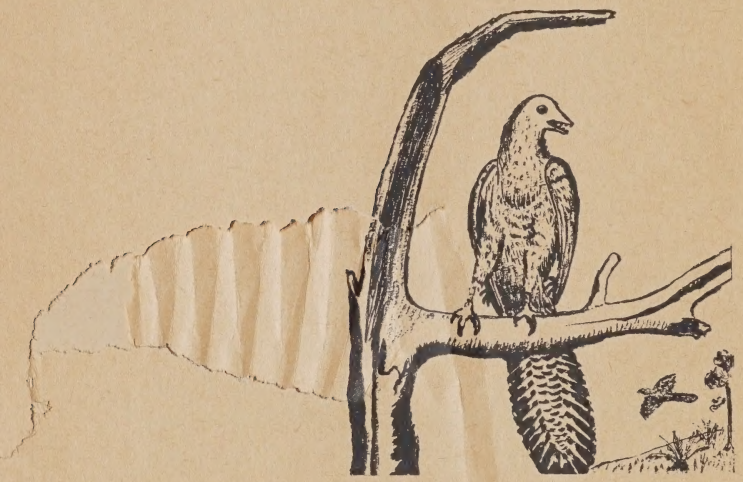
Besides the "duckbills" there are the "horned dinosaurs," a varied race of bulky quadrupeds. From one to three horns of many shapes and sizes bedecked the head, while a flanging, bony frill extended backwards over the neck.

The flesh-eaters were fierce, swift-moving, bipedal animals with large heads and powerful, sharp teeth and claws. The front limbs were very small and were used probably for grasping the prey and tearing the flesh. The most spectacular of the flesh-eaters is *Tyrannosaurus rex*, the king of the tyrant lizards. Skeletons of these creatures measure as much as 47 feet long, and 20 feet tall, with the head 4½ feet long and 3½ feet high, the jaws of which show conical teeth 6 inches long.

In spite of the world-wide distribution of the dinosaurs, their great numbers, and their extreme variation, they, like most of the previous dominant groups, in due time showed signs of weakening and by the end of the Mesozoic they disappeared forever from the stage of history.

During the Jurassic period of this same middle era, the first bird appeared. Aside from possessing feathers it was little more than a glorified reptile. *Archaeopteryx* (meaning "ancient feather"), as this bird was called, possessed jaws in which reptilian-like teeth were well developed and numerous. The first specimen was nothing

more than the imprint of a feather, the oldest known to science. It was unearthed in limestone quarries at Solenhofen in Bavaria in 1860. One month later a nearly entire individual was discovered at the same locality. This specimen may now be seen in the British Museum of Natural History. In 1877 a third specimen,



ARCHAEOPTERYX, THE FIRST BIRD

the most complete yet known, was found in the same area. Although not an *Archaeopteryx*, it is closely related. These two fairly complete specimens and the one feather are the only authenticated remains of Jurassic birds that have been discovered up to the present time. Birds were probably numerous, however, but owing to their aerial and land habits their skeletons escaped preservation by falling in unfavourable spots for permanent burial.

"*The mammals inherit the earth.*" Towards the end of the Mesozoic the earth was greatly changed. The vast seas that had formerly covered the interior of the

continents withdrew; great mountain chains arose, including the Rockies in North America; and the courses of ocean currents were altered. It is not surprising to find new animals and plants, stimulated by such stupendous geographic changes, replacing those that flourished in the older world.

In the plant kingdom appeared trees that bore conspicuous flowers, shed their leaves, and produced fruits. They soon became the characteristic plants replacing, in the economy of nature, the evergreens, the gingkos, and the cycads, the outstanding Mesozoic types.

Early in the Cenozoic, in the Tertiary period, grasses appeared on the central plains of the continent. Such plants influenced in no small way the new animals that were developing at this time, namely, the mammals. They found vegetable food in greater abundance than had ever before existed. Since they had no reptiles to fear other than crocodiles, snakes, and turtles, it is little wonder that they began to thrive in great variety and abundance. Soon they were to become the dominant creatures of the earth. Though a rich fossil record of mammalian life is known it is by no means proportionate to the great numbers that have existed since the beginning of the Cenozoic. It must be realized that in the past, as now, most mammals lived upon the land. When they died their remains lay for the most part in exposed places where they were either dismembered and devoured by other animals or destroyed by eroding forces, so that no record was left of their existence. Some few were quickly buried by nature in swamps, in lake beds, in ice, in asphaltic beds, or some other favourable medium, and were thus preserved to posterity.

The oldest Cenozoic mammals are mostly small, very generalized varieties. Among them there were both

plant-eaters and flesh-eaters, exhibiting more varied and complex teeth than the reptiles. None of these older mammals could be recognized at first sight as being directly related to animals that live to-day. To illustrate, let us take a mammal familiar to us all, the horse. Its ancestral type, which dates back some fifty millions of years, was a small, probably five-toed animal, not larger

An Early Cenozoic Horse

than a medium-sized dog, with low-crowned teeth for browsing. Through a regular series of fossil forms, from the beginning of the Cenozoic to the Recent, successive changes in the ancestry of the horse may be traced. These changes involve increase in size, loss of toes, and formation of the middle toe into the hoof, together with lengthening of the crown of the tooth as a more efficient structure to accompany the gradually developing grazing habit.

Similar changes may be noted in the elephant tribe, the latest extinct types being the Mastodon and Woolly Mammoth of the Great Ice Age, which the more nor-

therly countries of the world experienced during the last million years, a mere yesterday in geological time. Teeth and tusks (a modified incisor) of these animals are commonly found in the superficial deposits from coast to coast in the Dominion and as far north as Alaska. Occasionally nearly complete skeletons are unearthed. Frozen carcasses in the Siberian tundras, with their shaggy coats preserved, attest to their survival during the closing years of the Ice Age.

Developing along with these more familiar creatures, and constituting part of Nature's great pageant, were countless numbers of mammals, many extremely bizarre in appearance—some large and bulky, others small and highly specialized, that dropped out of the long procession of life, leaving behind no direct descendants.

Man takes over. Fossil remains of humans, the highest of all the mammals, are exceedingly rare. Many factors have combined to deprive us of a clear record of man's rise to his present position of dominance over the other creatures of the earth. Ancestral man, for instance, probably lived in well-wooded regions where the humic acids destroyed the buried remains. Furthermore, being more intelligent than the lower animals, man avoided, as far as possible, swamps or other dangerous places, where natural burial in accumulating sediments would make preservation more likely. In addition, it is possible that many bodies were cremated or otherwise destroyed in the practice of primitive tribal burial rites.

In spite of such unfortunate circumstances the ancestors of modern man can be traced back a million years or more, that is to say, through the late Cenozoic into the Pleistocene period or back even farther. The very oldest evidence of man is not skeletal remains

but rather crude flint implements worked by him and known as eoliths, meaning "dawn stones."

Probably the oldest, and the most primitive of all the actual fossil remains of man's direct ancestors, is the *Pithecanthropus erectus* from Java, found in 1891. The skull and a few other bones are all that are known of this particular type. Another early form, representing a somewhat more advanced race, was first revealed by several discoveries near Peking, China, as recently as 1928. The name *Sinanthropus pekingensis* was applied to this type. Another probably contemporaneous race is represented by remains of portions of the head discovered in 1911, and several successive years, in river gravels at Piltdown, England. This type is called *Eoanthropus piltdownensis*.

These three races flourished during the first Interglacial period (950,000 to 630,000 B.C.), when the ice had retreated northward in Europe and Asia, leaving in the more southerly regions a genial climate which made living conditions more favourable for primitive man.

To the second Interglacial (550,000 to 225,000 B.C.), belong the human remains known as *Palaeanthropus heidelbergensis*, which were found near Heidelberg, Germany, in 1907. The jaw and teeth of this form are so different from other finds that it is believed to represent a distinct type and, although large, it presents very human characteristics.

As we reach the third Interglacial period, which brings us to about 150,000 B.C., Neandertal man, *Homo neandertalensis*, appears on the scene in great numbers. He inhabited caverns in western Europe. The original discovery, made in 1857, came from Neander Valley, near Düsseldorf in Germany. These men were of a stocky, short build and upright posture. They made

fairly good implements, as evidenced by their crude stone axes, scrapers, and flint-tipped spears. Associated with the remains are mammals such as the bison, cave bear, horse, reindeer, mammoth, all of which were contemporaries in Europe.

Cro-Magnon Man

Neandertal man seems to have been replaced rather suddenly by a much finer human type of early *Homo sapiens*, known as Cro-Magnon man (25,000 B.C.). The original five specimens, representing different sexes and ages, were discovered in the rock shelter of Cro-Magnon, near the French village of Les Eyzres. These people were tall and straight, with long legs and apparently

freer in their movements than any before discovered. They had superior intellect and fashioned well-formed implements of stone and bone. That Cro-Magnon man was familiar with such prehistoric animals as the Woolly Mammoth is evidenced by paintings of these creatures on the walls of certain caverns in France and southern Spain. An artistic development was, therefore, one of his accomplishments. With the retreat northwards of the last great ice sheet the Cro-Magnons, the last of the Palaeolithic races, disappeared.

While the types mentioned in the foregoing do not represent all the known finds of fossil men, they are the most outstanding. It might also be noted that in addition the continents of Africa and Australia have each produced certain evidence of the existence of prehistoric man.

As the ice sheet withdrew, the climate moderated and the Recent epoch began, possibly 25,000 years ago. Neolithic man, with his progressively higher cultures, quickly spread in all directions from the probable place of origination in southern Europe. With the spread of this early culture, civilization is thought to have begun. More permanent dwellings replaced earlier casual cave habitations; community life was started; animals were domesticated ; and the art of making pottery was gradually developed. From that time on history deals with modern man and our story of ancient life ends.

Before closing this brief account of life through the ages it might be stated that no authentic fossil remains of prehistoric man in North America have as yet been found. All the specimens known to science have come, as we have seen, from other continents. New World archaeological research in the field of early man, has proved, however, that man was present in North America, where he was definitely associated with now extinct mammals like the Woolly Mammoth and Sabre-tooth

Tiger, in the latter part of the Great Ice Age. The evidence is based upon artifacts, particularly flint arrow heads. Though these relics are found in widely separated regions, New Mexico has been perhaps the most fruitful field. More than one cultural period is now recognized and they seem to date from about 25,000 to 8,000 B.C. Further investigations may substantiate an existing belief that man migrated to North America during the European Upper Palaeolithic period from Asiatic sources by way of Behring Strait. This early man may have been the progenitor of our North American Indian and was in all likelihood physically very similar to him.

Epilogue. Let us now sum up this account of our earth and its inhabitants through countless ages in the following lines:

So this planet that we call the Earth,
Began very early in time
As a hot, seething mass
Of vapours and gas
Dragged out from its parent, the Sun.

With the passage of eons unknown,
This mass that was formless and void
Took a shape as it cooled
And order soon ruled
As the life-bearing waters came on.

At first tiny One-Celled forms
Thrived alone in the primary seas.
Though no record remains
Of these jelly-like grains
That they lived we most firmly believe.

As the ages moved slowly along,
Spineless creatures protected by Shells
Filled the waters of old
In numbers untold
For two hundred millions of years.

With the further passing of time,
True Fishes with well-formed backbones,
Without making a sound,
Swam boldly around
A creation indeed to behold.

But these new overlords of the seas
Grew tired at last of their homes.
So a few ventured out
Though filled with some doubt
As to how on the land they could breathe!

Thus came the Amphibians bold,
Whose reign from the outset was doomed
For they could not keep pace
With the great Reptile race
Whose rule was about to begin.

Of these Reptiles, above all the rest,
Stood the Dinosaurs, mighty and strong,
They laid eggs in the sands
And wandered in bands
All over the world it would seem.

But the Reptiles at last disappeared—
Except for a few puny forms—
That live on till to-day
And in their own way
Demonstrate the last of their kind.

And now we have come to the end
Of our narrative dealing with life,
For the mammals, now strong,
And to which we belong
Lead at last this pageant of time.